Spectromicroscopy of cells, tissues and minerals at the 10-100 nanometer scale

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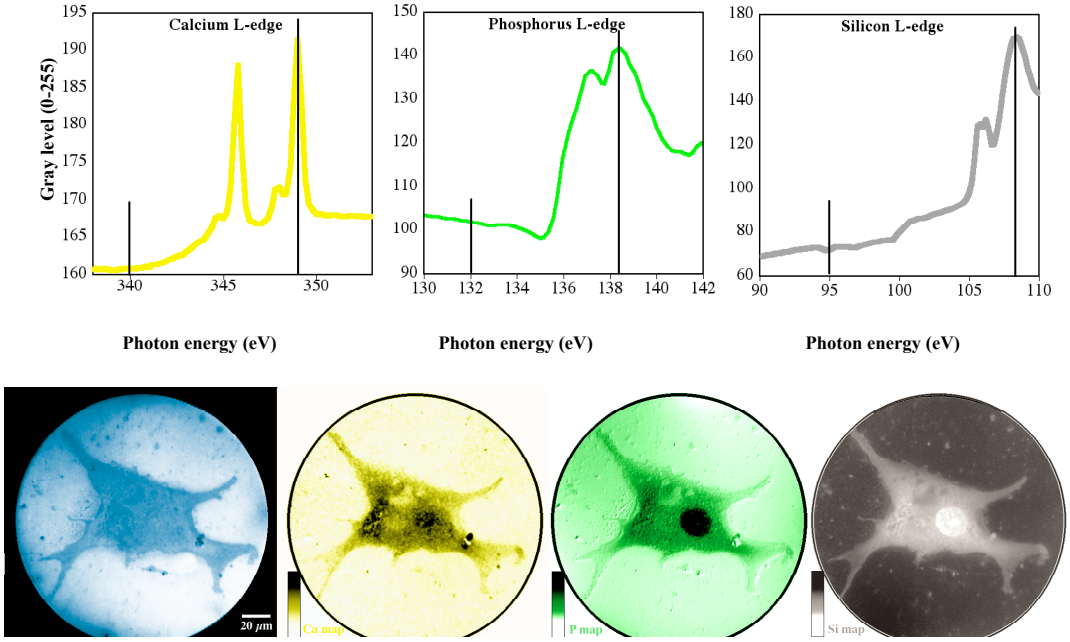
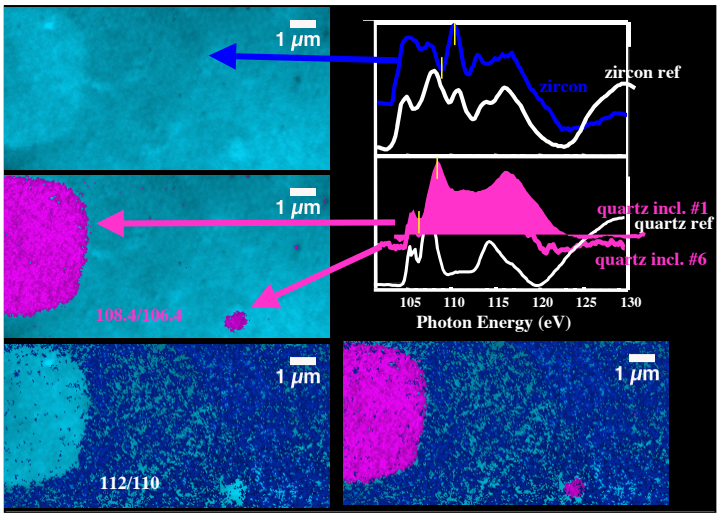
X-ray PhotoElectron Emission spectroMicroscopy (X-PEEM) (1) has now reached a stage of maturity and is widely used in materials science. Our group, however, uses X-PEEM in combination with TEM, SEM and other methods to investigate other systems. These include, as the title suggests, cells (both eukaryotes and bacteria) (2-5), tissue sections (6,7), minerals (8,9), and biominerals (10,11).
GdNCT is a novel kind of brain cancer therapy that our group developed. The relative X-PEEM experiments are aimed at verifying that Gd targets the nuclei of glioblastoma cells, in cell cultures in vitro or in vivo, in brain cancer tissue sections from animals or human cases. Figure 1 shows typical cells for this analysis. More extensive data can be found in Refs. 2 and 6.

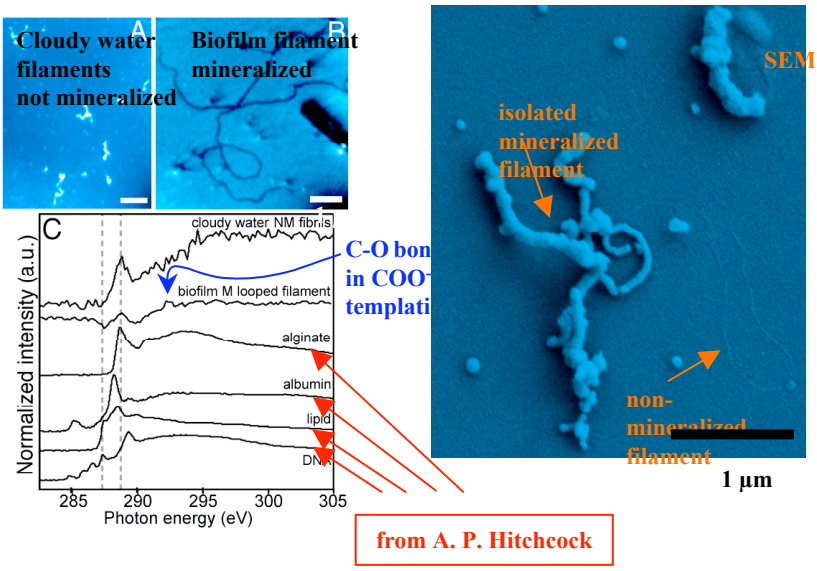


Cyanobacteria revealed to X-PEEM analysis that the outer sheath surrounding them is not single but double, suggesting that there were multiple endosymbiotic events, when these bacteria were incorporated into plant cells to become choroplasts, the subcellular organelles in which photosynthesis takes place (5).

A new differential-thickness coating approach, allows us to analyze perfect insulators, such as mineral crystals (8,9). Among these we have studied inclusions in the oldest piece of rock known, a 4.4 billion-year-old zircon from Australia (12). Some of the inclusions (e.g. the ones in Fig. 2) were too small to be analyzed with any other non-destructive technique.



Biominerals are all those inorganic materials templated by organic molecules, such as bone, shells, and biofilms of mineralizing bacteria. With X-PEEM for the first time the interface between organic and inorganic matrices in biominerals is accessible for analysis, and the templation mechanisms can, therefore, be revealed at the molecular level. The first evidence of one such mechanism, and the X-PEEM data that revealed it, were published earlier this year (10,11). We anticipate this to be an extremely fertile field, which will engage our group and others for the future several years.



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